DEMONSTRATION AND VALIDATION OF TECHNOLOGIES TO MITIGATE CORROSION ON INFRASTRUCTURE COMPONENTS AT FORT BRAGG:

INITIAL RESULTS

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Outline

- Corrosion Issues at Fort Bragg
- Project Description
- Technical Approach
  - Evaluation Procedures
- Technology Application
- Results
- Summary

Corrosion Issues at Fort Bragg

- Serious corrosion of infrastructure components evident at Fort Bragg, NC
- Two key issues
  - Mechanical Rooms
    - Example - newly constructed 16th Military Police Barracks
      - Accelerated corrosion of exposed union joints
      - Significant amount of condensate build-up on insulation covering supply lines
  - Cooling Tower Pumps
    - Relatively new (put on line in 1996) central cooling plant
    - Vertical cooling towers and pumps corroding
    - Total failure due to corrosion within two to four years of operation

Corrosion Issues at Fort Bragg (cont.)

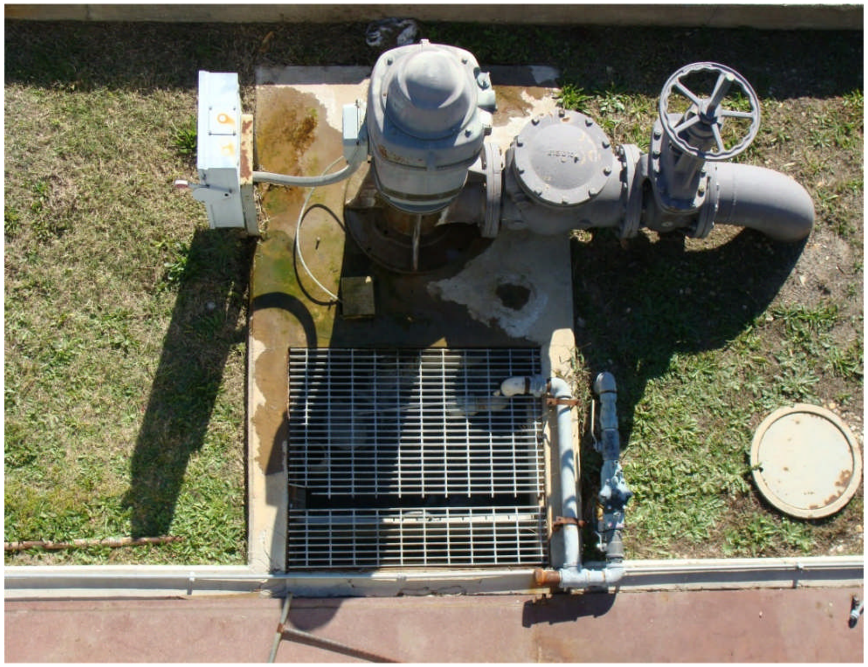
- Mechanical Room Piping

Mechanical Room at Fort Bragg, with corroded piping union joints

Corrosion Issues at Fort Bragg (cont.)

- Cooling Tower Pumps

Cooling towers, Central Cooling Plant, Fort Bragg



Overhead view of pump sump

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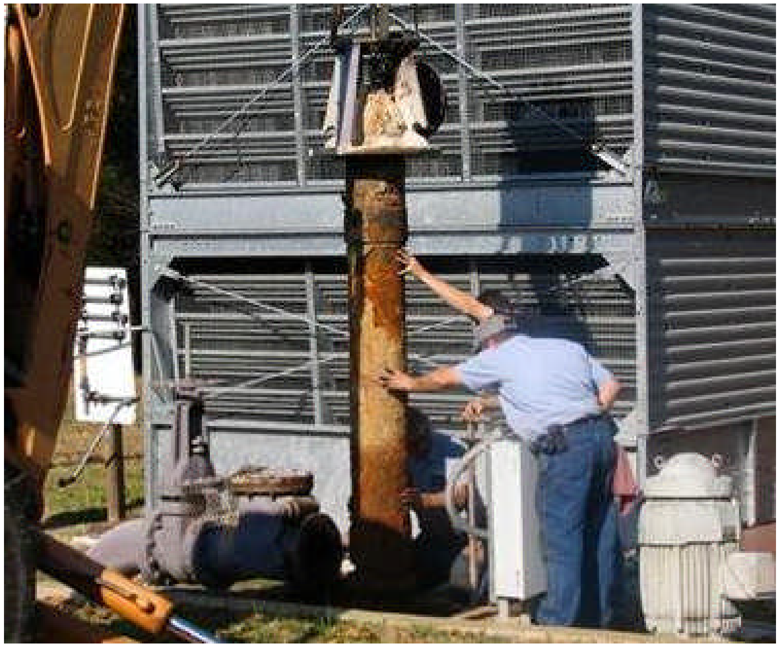
Corrosion Issues at Fort Bragg (cont.)

- Cooling Tower Pumps (cont.)



Removed pump, showing severe corrosion on shaft (near water surface)

Project Description

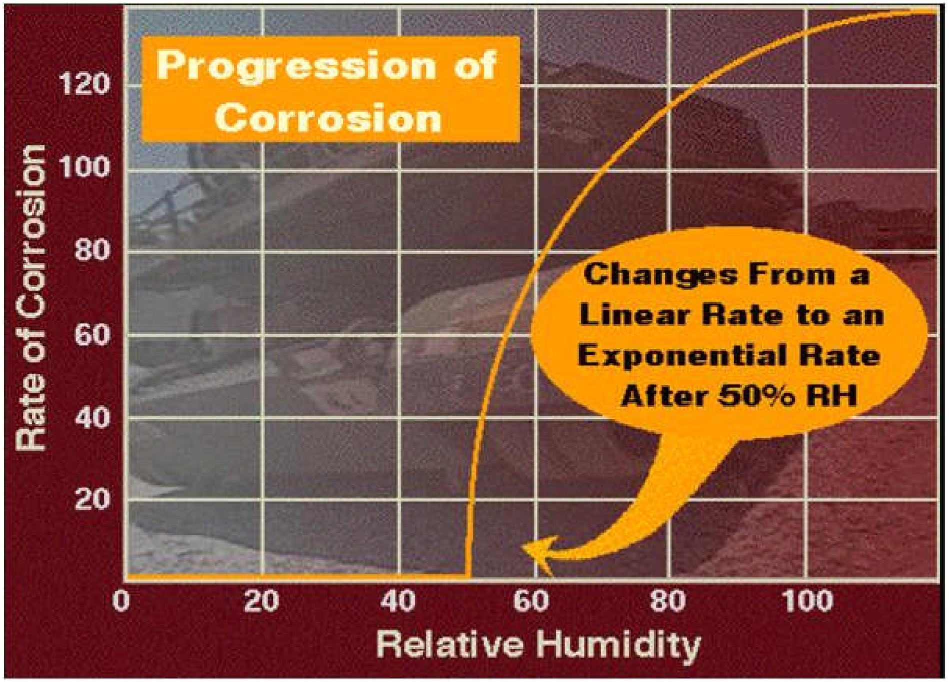
- "Demonstration and Validation of Technologies to Mitigate Corrosion on Mechanical Room Utility Piping and Cooling Tower Pumps at Fort Bragg, NC"
- Sponsored by the Office of the Secretary of Defense (OSD) under the Corrosion Technologies for Defense Systems and Infrastructure (CTDSI) Program

Technical Approach

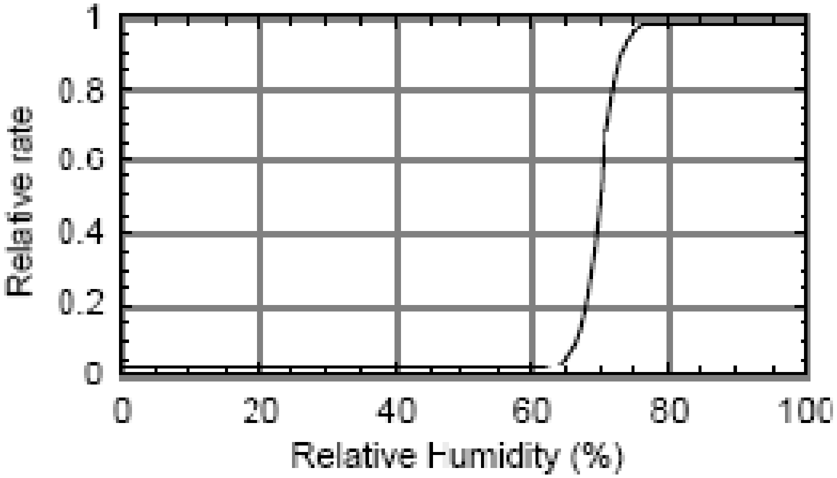
- Mechanical Room Piping and Joints
  - Focus on commercial off the shelf (COTS) solutions
  - Mechanical Room A: Evaluation of Two High Performance Coating Systems
    - White-pigmented, moisture-cure polyurethane coating
    - Ceramic-filled, insulating coating
    - Removable insulation system over top of polyurethane coating
  - Mechanical Room B: Evaluation of Dehumidification System
  - Mechanical Room C: Control

Technical Approach (cont.)

- Dehumidification Systems for Corrosion Protection
  - Mechanical Room B
  - Benefits clearly demonstrated in past efforts



SOURCE: D. Perkins and T. Carlson, "Army National Guard Controlled Humidity Preservation Program Overview," 2001 U.S. Army Corrosion Summit, St. Petersburg, FL, February 2001



SOURCE: Rob Sorensen and Jeff Braithwaite, "Statistical Modeling of Corrosion Induced Electronic Failures," Presentation for 1997 Life Cycles Workshop, Sandia National Labs, November 4, 1997

Technical Approach (cont.)

- Cooling Tower Pumps
  - Focus on COTS solutions
  - Two controls
    - One brand new pump
    - One recently-refurbished pump
  - Two High Performance Coating Systems
    - Paint System No. 21-A-Z
      - Recommended by ERDC-CERL
      - MIL-DTL-24441/19B zinc-rich epoxy (primer), MIL-DTL-24441 Formula 151 (topcoat)
    - "High Performance" Coating System
      - Recommended by coating applicator
      - Already on recently-refurbished pump
      - Epoxy (primer), Multi-Purpose Epoxy (topcoat)
  - Corrosion-Resistant Alloy
    - 316 stainless steel shaft (proposed by manufacturer)

Evaluation Procedures

- Applied Coatings, Insulation, Systems
  - Evaluate in accordance with ASTM and other relevant specifications
- Corrosion Test Coupons in Mechanical Rooms
  - Mild steel, 3" by 6"
  - Two each of different coating systems and two uncoated, bare steel panels
  - One coated test panel for each coating system scribed to base metal in accordance with ASTM D1654; other un-scribed
  - Condition of test panels documented and photographed upon installation
  - Visually inspected on monthly interval

Evaluation Procedures (cont.)

- Corrosion Test Coupons in Cooling Pump Sumps
  - Same procedure as for those in mechanical rooms
- Corrosion Sensors in Cooling Pump Sumps
  - Measure and monitor corrosivity of water system with corrosion rate monitors (electrical resistance sensors)

Technology Application

- Mechanical Room Piping and Joints
  - Existing rust from exposed piping removed
  - Coating systems applied

Pre-installation, chill water pump: rust evident even on stainless steel flanges

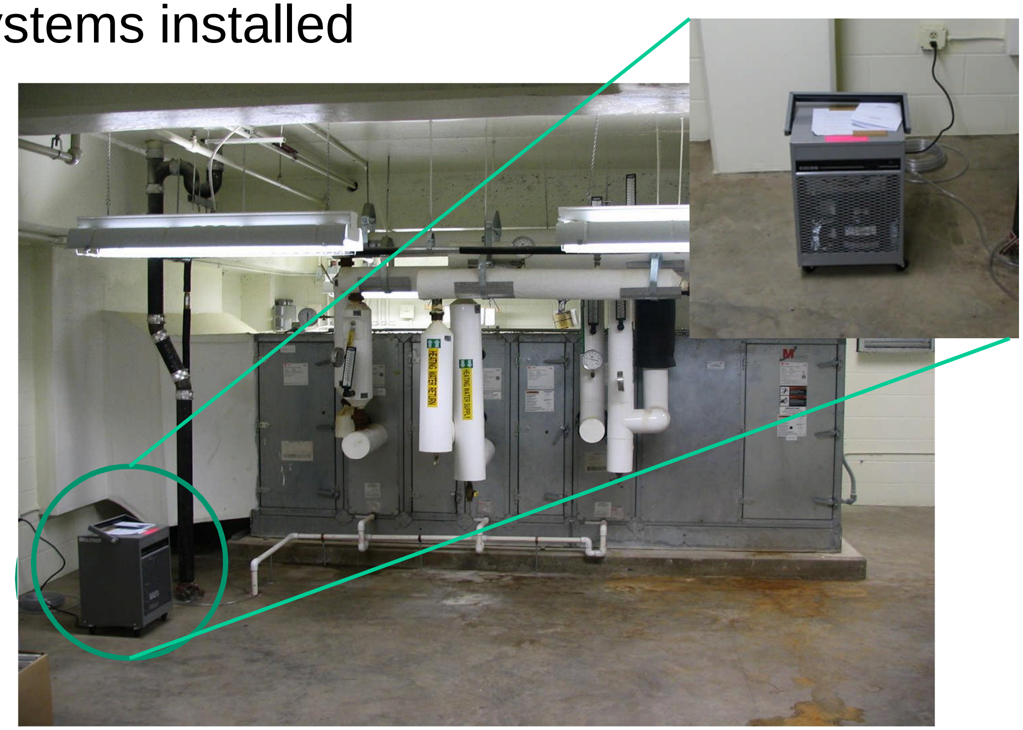
Primer: aluminum-loaded polyurethane

Ceramic topcoat

Technology Application (cont.)

- Mechanical Room Piping and Joints
  - Additional protective systems installed

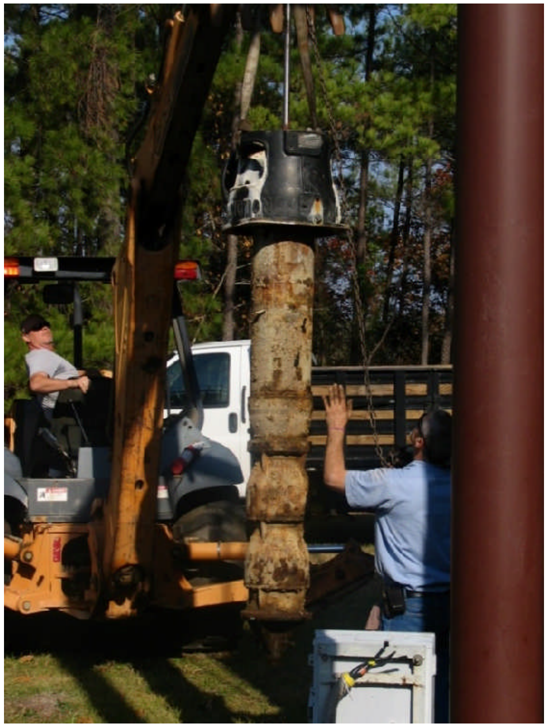
Removable insulation



Dehumidification used in another mechanical room

Technology Application (cont.)

- Cooling Tower Pumps
  - Pumps removed
  - Sandblasted to remove corrosion



Pump being removed

Sandblasting

Technology Application (cont.)

- Cooling Tower Pumps
  - Coating systems applied
  - Pumps reinstalled

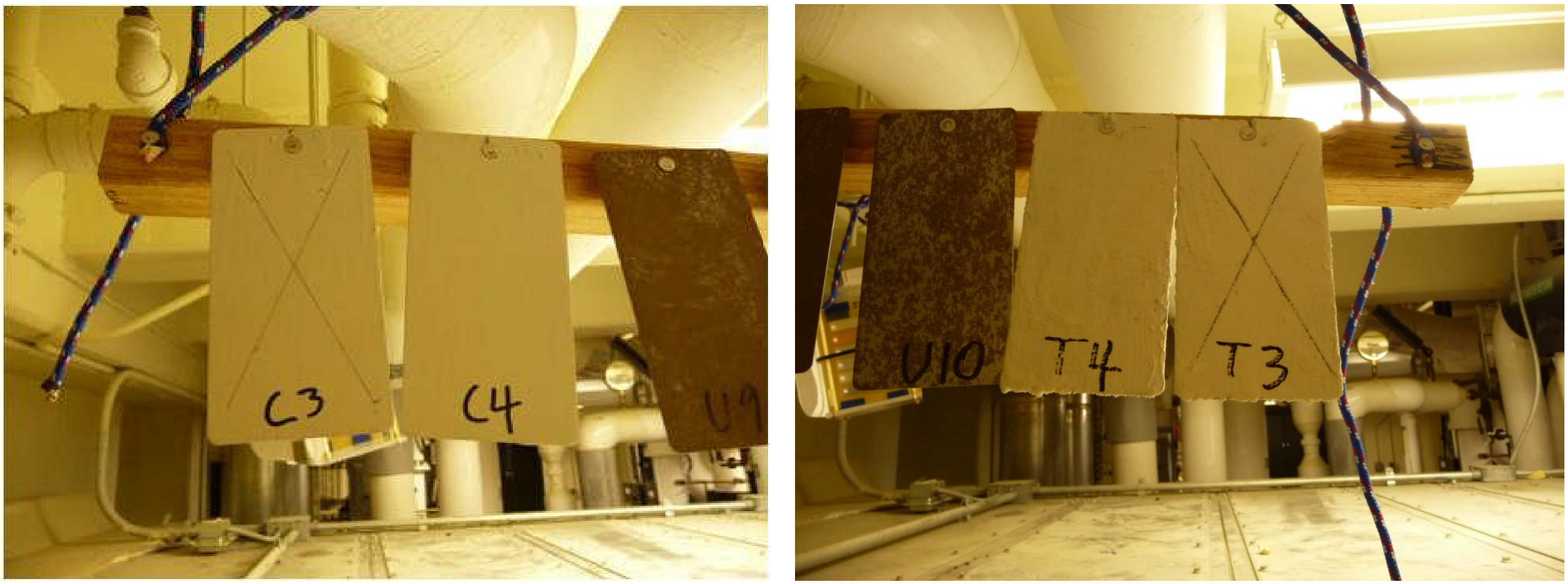
Paint System No. 21-A-Z

Epoxy System

316 Stainless Steel

Results

- Mechanical Rooms
  - Coated test panels in all mechanical rooms pristine after twelve months of exposure



Coated Test Panels, Mechanical Room A, Twelve Months of Exposure

Results (cont.)

- Mechanical Rooms (cont.)
  - Coated fittings generally performed well
    - Some corrosion after twelve months of exposure, but only in certain instances
    - Both coatings performed better on hot water lines than on cold water lines, as expected
      - Condensation on cold water lines is a contributor
    - Performance not consistent on all fittings

Coated Union Joints, Mechanical Room A, Twelve Months of Exposure

Results (cont.)

- Mechanical Rooms (cont.)
  - In general, the removable insulation was not effective
    - Difficult to apply, loose fitting
    - Accumulated water (condensation) that dripped out of the ends

Union Joint with Removable Insulation, Mechanical Room A, Nine Months of Exposure

Union Joint with Insulation Removed, Mechanical Room A, Twelve Months of Exposure

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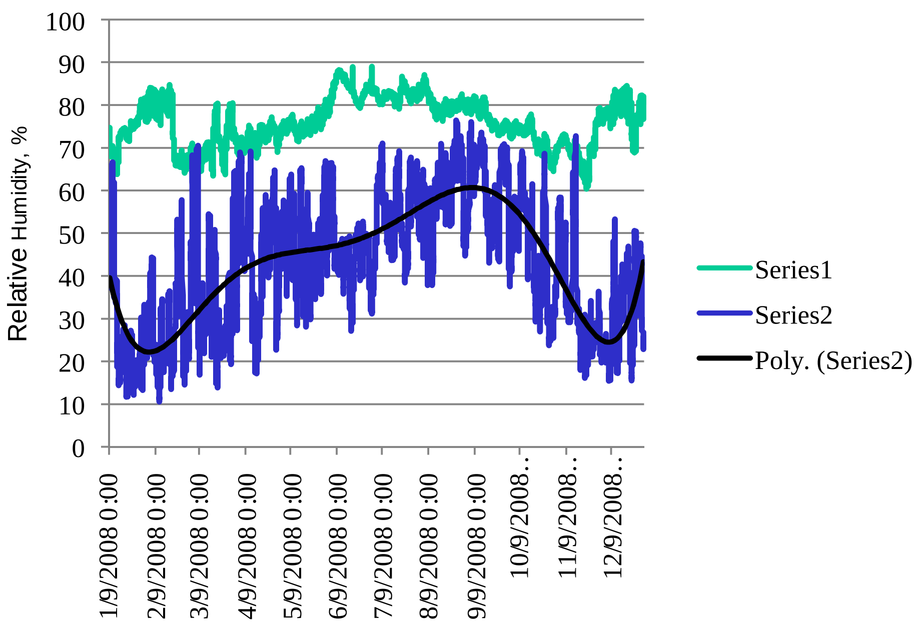
Results (cont.)

- Mechanical Rooms (cont.)
  - In general, dehumidification was not effective
    - Dehumidifier, although correctly sized for Mechanical Room B, was not able to effectively and consistently reduce humidity (and subsequently corrosion) in that room



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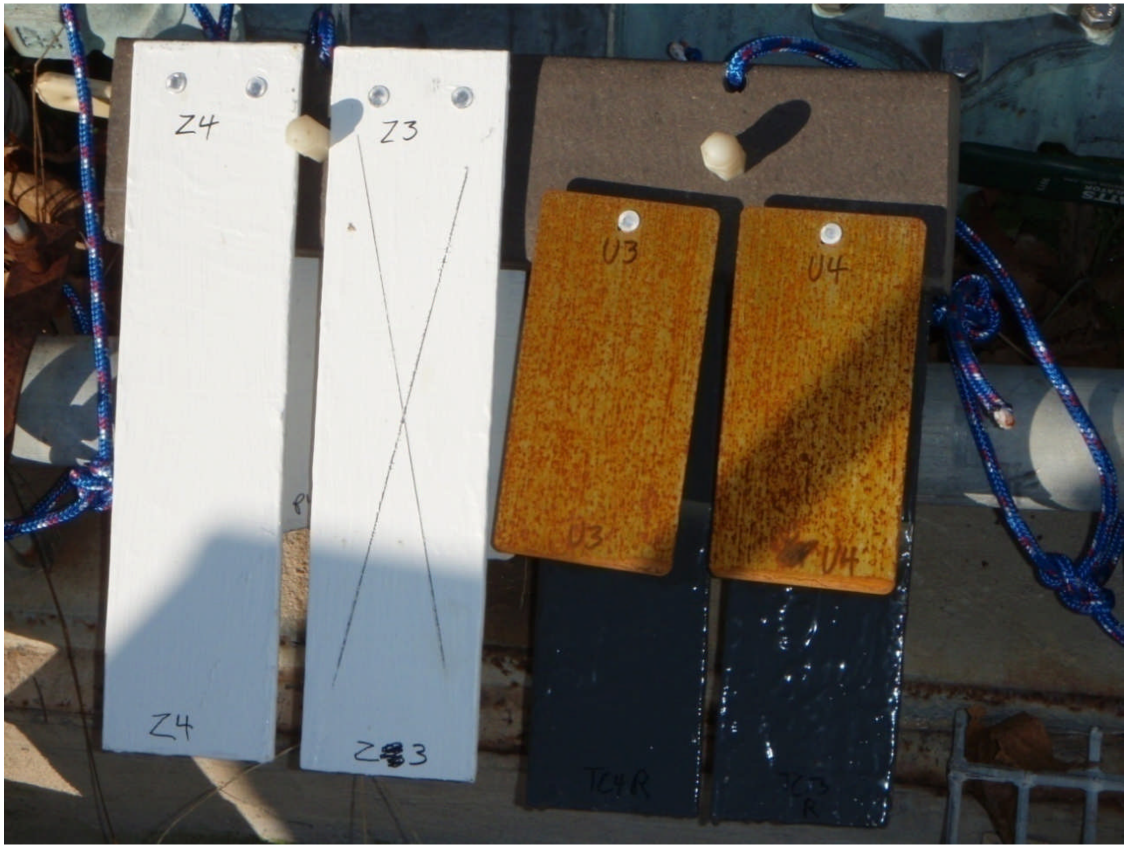
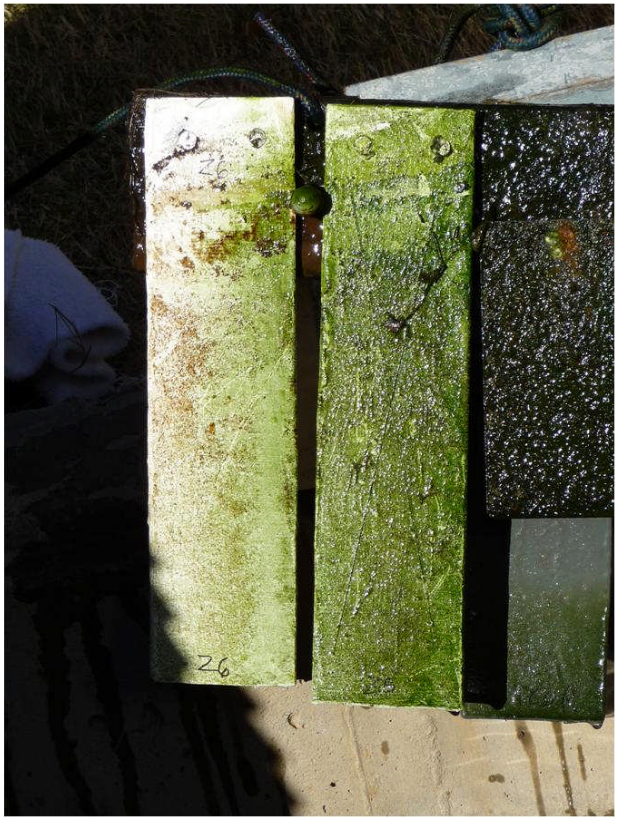
Results (cont.)

- Cooling Tower Pumps
  - Corrosion observed on uncoated panels in sumps in Feb 2009 (one-month exposure)



Results (cont.)

- Cooling Tower Pumps (cont.)
  - After twelve months of exposure, Paint System No. 21-A-Z outperformed commercial epoxy system



Summary

- A number of critical infrastructure corrosion issues have been identified at Fort Bragg
  - Two of the most critical involve the corrosion of piping union joints in mechanical rooms and the corrosion of cooling tower pump shafts
- A number of technologies to mitigate the subject corrosion issues have been identified and are being demonstrated
  - Advanced coatings, removable insulation, and dehumidification for mechanical room piping
  - Advanced coatings and materials for cooling tower pump shafts

Summary (cont.)

- Mechanical Room Technologies
  - Both coatings were effective in reducing corrosion in twelve months of exposure
  - Coatings more effective on hot water lines than cold water lines
  - Corrosion appears to be due to condensation rather than atmosphere
  - Neither dehumidification nor removable insulation appeared to be effective as stand-alone technologies
  - Combination of coatings and dehumidification may be optimal
- Cooling Tower Pump Technologies
  - After twelve months of exposure, Paint System No. 21-A-Z outperformed commercial epoxy system

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  - Honeywell Fort Bragg

Thank You!

Questions?

Backup Slides

Introduction - Corrosion of Military Infrastructure

- Military facilities affected by severe corrosion
  - CONUS and OCONUS
  - From 2003[1]:
    - More than two-thirds of military facilities unable to meet certain mission requirements
    - Degradation of runways and airstrips
    - Degradation of maintenance facilities (Navy aircraft hanger ceiling)
    - Corrosion of aircraft refueling equipment
    - Corrosion of fire protection assets
    - Degradation of electrical and command/control facilities
- Application of appropriate available corrosion prevention technologies (coatings, materials, etc.) can address this problem

[1]*Source: "Defense Management: Opportunities to Reduce Corrosion Costs and Increase Readiness," United States General Accounting Office Report to Congressional Committees, July 2003*

Project Description (cont.)

- Project Objectives
  - Demonstrate/validate technologies to address corrosion problems in barracks mechanical room piping/joints and cooling tower pumps/systems at Fort Bragg, NC
  - Modify standard operating procedures and procurement guidelines as needed
  - Demonstrate enhanced long-term system reliability and safety at reduced costs compared to current practices
- Project Team
  - Concurrent Technologies Corporation (*CTC*)
  - U.S. Army Corps of Engineers, Engineer Research & Development Center Construction Engineering Research Laboratory (ERDC-CERL) – Project Manager
  - Fort Bragg Department of Public Works (DPW)
  - Other contractors